Construction and Application of an Innovative Service System for Rural Tourism Based on Smart Tourism Platforms

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Abstract. This study focuses on the construction and application of an innovative service system for rural tourism based on smart tourism platforms. By analyzing the current state of rural tourism service informatization and technological pain points, a multi-layered innovative system design is proposed. This system integrates core technologies such as artificial intelligence, big data, and blockchain to realize functions like smart navigation, personalized recommendations, and visitor flow management. The research details the implementation process of the system, including key algorithms, data management strategies, and deployment plans. Taking a provincial-level rural tourism demonstration area as a case study, the practical application effects of the platform are showcased. Performance evaluation results indicate that the platform significantly enhances user experience, optimizes scenic area management, and promotes economic benefits. This research provides new insights for the intelligent development of rural tourism and holds significant importance for advancing the rural revitalization strategy.

Keywords: smart tourism platform; rural tourism; service innovation; system construction; application evaluation.

1. Introduction

In recent years, with the deepening of the rural revitalization strategy and the rapid development of information technology, rural tourism has encountered new opportunities and challenges [1]. As an emerging tourism model, smart tourism provides crucial support for the transformation and upgrading of rural tourism. However, there are still many issues in the informatization and intelligent services of rural tourism, such as uneven levels of informatization, insufficient application of technology, and the need for improved service quality. This study aims to construct an innovative service system for rural tourism based on smart tourism platforms, exploring the application pathways of intelligent technology in rural tourism to enhance visitor experience, optimize scenic area management, and promote rural economic development. Through system design, technological implementation, and practical application, this research offers new ideas and solutions for the intelligent development of rural tourism [2]. This study is not only of great significance for promoting the digital transformation of the rural tourism industry but also provides strong support for achieving industrial integration and innovative development within the rural revitalization strategy.

2. Current State and Demand Analysis of Rural Tourism Service Informatization

2.1 Current State of Rural Tourism Service Informatization

In recent years, significant progress has been made in the informatization construction of rural tourism services. According to statistics, by the end of 2023, 65% of rural tourism scenic spots in the country had established official websites, and 78% of scenic spots had opened official accounts on mainstream social media platforms. However, there are regional disparities in informatization levels; economically developed regions have higher levels of informatization in rural tourism services [3]. For example, in Zhejiang Province, the online booking rate for rural homestays reached 85%. In contrast, the informatization construction of rural tourism in central and western regions lags behind, with only 30% of scenic spots offering online booking services, as shown in Table 1. Overall, the informatization process of rural tourism services is accelerating but still requires further improvement and optimization.This uneven development in the level of informatization not only reflects regional economic disparities but also highlights the need to focus more on underdeveloped areas during the comprehensive promotion of rural tourism informatization. It calls for the formulation of targeted support policies and technical assistance plans.

TABLE I. Comparison of Rural Tourism Informatization Construction Between Economically Developed Regions and Central-Western Regions

Region	Website Construction	Social Media Accounts	Online Booking
Economically Developed	90%	95%	85%
Central/Western	50%	60%	30%

2.2 Technical Pain Points in Rural Tourism Services

Rural tourism services face numerous technical challenges during their informatization process. As shown in Table 2, 57% of rural tourism practitioners report a lack of professional technical personnel, leading to difficulties in system maintenance and upgrades. Additionally, 46% of scenic spots indicate that inadequate network infrastructure hampers the promotion of intelligent services [4]. In terms of data security, over 60% of rural tourism enterprises state that they lack effective data protection measures. Regarding visitor experience, a survey reveals that 72% of tourists desire more personalized service recommendations, yet currently only 25% of rural tourism platforms can offer intelligent recommendations based on user profiles. Addressing these technical pain points is crucial for enhancing the quality and competitiveness of rural tourism services.

TABLE II. Survey Results on Technical Pain Points from Rural Tourism Practitioners and Tourists

Technical Pain Points	Percentage (%)
Lack of Skilled Technical Personnel	57
Inadequate Network Infrastructure	46
Insufficient Data Protection Measures	60
Visitors Want Personalized Service Recommendations	72
Actual Platforms Providing Personalized Services	25

3. Construction of an Innovative Service System for Rural Tourism Based on Smart Tourism Platforms

3.1 Overall Architecture of the Innovative System

The innovative service system for rural tourism based on smart tourism platforms employs a multi-layered architectural design, including an infrastructure layer, data layer, service layer, and application layer, as shown in Figure 1. The infrastructure layer consists of cloud servers, IoT devices, and 5G networks, providing hardware support for the entire system. The data layer is responsible for collecting and processing tourism-related data from various channels, including visitor behavior, scenic spot information, and environmental monitoring. The service layer integrates core technologies such as artificial intelligence, big data analytics, and blockchain, providing intelligent service support for upper-layer applications [5]. The application layer is aimed at end users, offering functionalities such as smart guides, personalized recommendations, and virtual experiences. This architectural design ensures the system's scalability and flexibility, making it adaptable to different scales and types of rural tourism scenarios. The layers communicate through standardized interfaces, achieving a loosely coupled design that facilitates system maintenance and upgrades. At the same time, the entire architecture takes security and privacy protection into account, with corresponding security measures implemented at each layer, such as data encryption, access control, and real-time monitoring, to ensure the safe and reliable operation of the entire ecosystem.

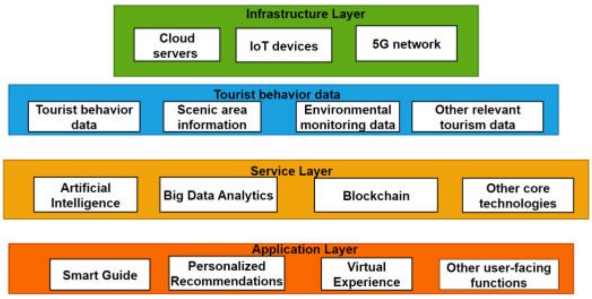

Figure 1. Overall Architecture of the Innovative System

3.2 Core Technology Selection

The smart tourism platform integrates multiple cutting-edge technologies, providing comprehensive support for rural tourism services. In the field of artificial intelligence, deep learning algorithms such as Convolutional Neural Networks (CNN) are used for functions like image recognition, natural language processing, and personalized recommendations：

$$(\mathrm{CNN}，f(x) = \sigma(W_x + b)$$

Where σ is the activation function, W is the weight matrix, and b is the bias term. Recurrent neural networks (RNNs) handle voice data, enabling smart voice interaction and species recognition in scenic areas. For big data analytics, the Hadoop MapReduce paradigm represents the mapping and reduction functions, and Spark's RDD operations (e.g., RDD.map(f).reduceByKey(g)) efficiently process massive tourism data, enabling visitor behavior analysis and targeted marketing. Blockchain technology ensures the security and reliability of tourism points systems and credit evaluations through cryptographic hash functions [6]. IoT technology combines RFID,augmented reality (AR) technology uses projection matrices.

$$f = \frac{c}{4\pi d^2}$$

$$P = K[R|t]$$

Where,f represents signal strength, c is a constant, d is distance, and the sensor network enables real-time monitoring and intelligent management of scenic areas,K is the camera intrinsic parameter matrix, R is the rotation matrix, and t is the translation vector, providing immersive tourism experiences such as historical scene re-creation.Natural language processing (NLP) technology supports intelligent customer service and multilingual translation, while support vector machine (SVM) algorithms are used for predicting tourism demand.

$$\mathrm{sim}(a,b) = \cos(a,b) = \frac{(a\cdot b)}{||a||\,||b||}$$

Collaborative filtering algorithms:sim(a,b) indicates the similarity between vectors a and b; cos(a,b) represents the cosine value between vectors a and b;||a||and||b|| are the magnitudes (or lengths) of vectors a and b, respectively. This formula represents cosine similarity, used for personalized recommendations. The selection and integration of these core technologies not only enhance visitor experience but also optimize scenic area management efficiency, providing robust technical support for the intelligent and sustainable development of rural tourism.

3.3 System Function Module Design

The design of the system function modules for the smart tourism platform focuses on two main directions: visitor needs and scenic area management. The visitor service module includes functions such as smart navigation, personalized recommendations, online booking, and virtual experiences. The smart navigation feature uses GPS positioning and AR technology to provide real-time route planning and display of attraction information. The personalized recommendation system utilizes collaborative filtering algorithms to suggest suitable attractions and activities based on visitor preferences [7]. The scenic area management module includes functions such as visitor flow monitoring, environmental monitoring, and emergency response. Visitor flow monitoring employs video analysis technology to keep track of crowd distribution in real-time, effectively preventing congestion. The environmental monitoring system collects data on air quality, noise, and other metrics through IoT sensors, ensuring the quality of the scenic area environment. The design of these function modules aims to enhance visitor experience and improve operational efficiency in scenic areas, achieving intelligent and refined management of rural tourism services.

4. Implementation and Integration of the Intelligent Service System

4.1 Key Algorithms and Technology Implementation

In the implementation of key algorithms for the intelligent service system, the smart navigation function employs the TensorFlow framework to build deep learning models. For attraction recognition, a pre-trained ResNet model is used as the foundation, fine-tuned with a local dataset through transfer learning. This process can be represented by the following formula:

$$f(x) = \mathrm{softmax}(W \cdot \mathrm{CNN}(x) + b)$$

The voice interaction feature is based on the open-source Kaldi speech recognition toolkit, combined with an LSTM model to optimize the speech-to-text conversion process. The implementation of the personalized recommendation algorithm is done using Python, integrating the Spark MLlib library to construct the collaborative filtering model. For visitor flow prediction, an LSTM network is built using the Keras framework, with hyperparameters optimized through the Grid Search method. The implementation of AR technology is based on the Unity3D engine, combined with the Vuforia SDK to complete the 3D reconstruction of scenic areas and virtual content overlay [8]. The comprehensive application of these technologies ensures that the intelligent service system can provide high-quality, personalized user experiences while laying a solid technical foundation for future function expansion and performance optimization.

4.2 Data Management and Security Strategy

Data management is centered around the Hadoop ecosystem, utilizing HDFS to store raw data. As shown in Figure 2, the Sqoop tool facilitates data migration between relational databases and Hadoop, while Hive is used to build a data warehouse and execute data cleaning and transformation via HiveQL scripts. For data security, the Spring Security framework is employed at the application layer to implement authentication and authorization. Sensitive data encryption is achieved using the Java Cryptography Extension (JCE) library, implementing the AES encryption algorithm [9]. Transport layer security is ensured by configuring an Nginx reverse proxy server to enable SSL/TLS encryption. The system also employs the ELK stack (Elasticsearch, Logstash, and Kibana) for log analysis, enabling real-time monitoring of anomalous access. For blockchain technology, the Hyperledger Fabric platform is chosen, with smart contracts written to manage transaction information and user evaluations.

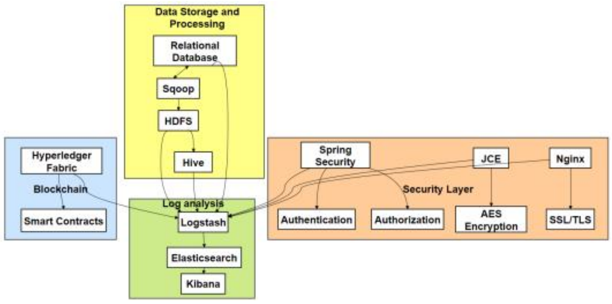

Figure 2. Data Management and Security Strategy Architecture

4.3 System Integration and Deployment

System integration adopts the Spring Cloud microservices framework, using Eureka for service registration and discovery. Each microservice is containerized using Docker, with Kubernetes managing container orchestration. Continuous integration and continuous deployment (CI/CD) processes are implemented through Jenkins, with a Jenkinsfile configured to define pipeline jobs, as shown in Figure 3. Version control is managed through Git, with GitLab serving as the code repository. For hybrid cloud deployment, Terraform is used to write Infrastructure as Code (IaC), achieving consistent deployment across cloud platforms [10]. Load balancing is configured using Nginx Plus, with Lua scripts for dynamic upstream management. For system monitoring, Prometheus is deployed as a time-series database, complemented by Grafana for visual monitoring dashboards. The alerting system is configured through Alertmanager and integrated with WeChat Work, ensuring that the operations team can respond promptly to system anomalies.

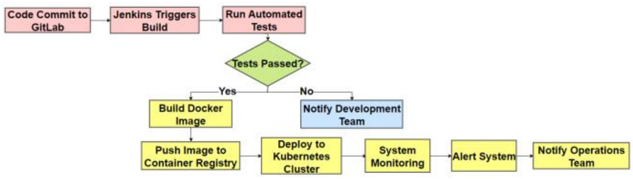

Figure 3. Continuous Integration and Continuous Deployment (CI/CD) Flowchart

5. Application and Evaluation of the Smart Tourism Platform in Rural Tourism Services

5.1 System Deployment Plan

The smart tourism platform adopts a layered architecture, integrating cloud computing and edge computing technologies. The core system is deployed in the cloud, leveraging the elastic resources of public cloud services to handle peak access, while edge nodes are set up in rural tourism areas to process local data. Cloud deployment involves selecting a cloud service provider, configuring a virtual machine cluster, deploying core applications and databases, and setting up auto-scaling policies. Edge nodes are deployed at the scenic area management center, including local caching and data processing modules. Network configuration involves establishing high-speed Wi-Fi, VPN, and CDN. Security measures include firewalls, intrusion detection, data encryption, and access control. System monitoring ensures stable platform operation, including performance tracking, daily maintenance schedules, and emergency response mechanisms. The overall deployment plan aims to provide efficient, secure, and scalable smart tourism services.

5.2 Application Case Analysis

Taking a provincial rural tourism demonstration area as an example, the smart tourism platform is widely applied. The smart navigation feature provides personalized route recommendations and AR attraction introductions via a mobile app. Visitor flow management utilizes cameras and sensor networks to monitor distribution, automatically issuing alerts and guiding dispersal. The environmental monitoring system uploads air quality and noise data in real-time, allowing managers to monitor through a visual interface. Smart booking integrates surrounding services, offering one-stop booking and big data analysis. In terms of cultural dissemination, the platform uses VR technology to showcase local culture and integrates dialect recognition features. The emergency command system can quickly locate affected tourists, coordinate rescue resources, and push safety information. These applications significantly enhance visitor experience, optimize scenic area management, and promote the intelligent development of rural tourism.

5.3 System Performance Evaluation

The performance evaluation of the smart tourism platform covers several key metrics, ensuring efficient operation and user satisfaction through comprehensive analysis. As shown in Figure 4, there is a relationship between the number of concurrent users and response time. It can be observed that as the number of concurrent users increases, the response time gradually rises; however, even at 10,000 concurrent users, the response time only increases to 350 milliseconds, remaining within an acceptable range. The platform maintains a good response speed even under high load, and user experience ratings are relatively high, indicating that user satisfaction during normal usage remains positive.

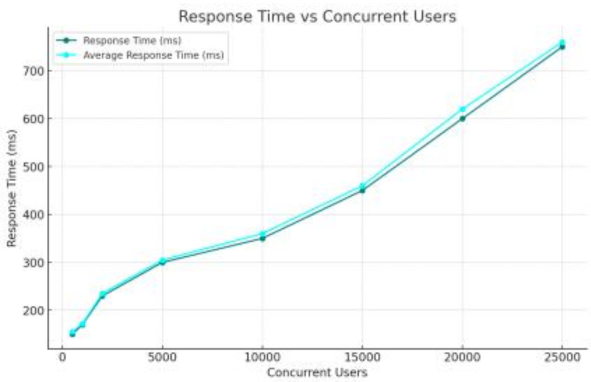

Figure 4. Concurrent Users and Response Time

The accuracy evaluation results of the smart recommendation feature are shown in Figure 5. With each version iteration, the recommendation accuracy steadily improves, with the latest version achieving an accuracy rate of 85%, which is a 15 percentage point increase compared to the first version. This significantly enhances the personalized user experience, and the increase in recommendation accuracy directly reflects the platform's progress in matching user needs. The rising number of user feedback submissions also indicates that user engagement and satisfaction with the platform are gradually improving.

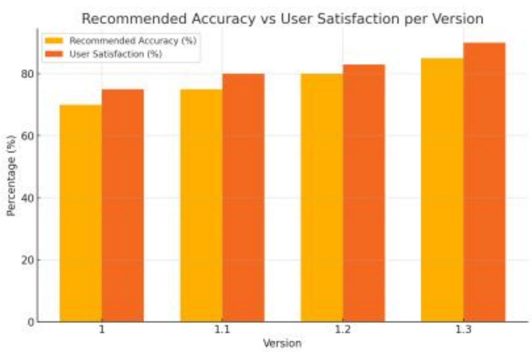

Figure 5. Recommendation Accuracy and User Satisfaction

Reliability testing results indicate that the system has not experienced major failures during continuous operation for 30 days, with a mean time between failures (MTBF) of 720 hours, far exceeding industry standards. This demonstrates the platform's high stability, with very few faults occurring and maintaining efficient and stable operation most of the time, thereby providing reliable service assurance to users.Security assessments conducted through simulated attacks identified and fixed multiple medium and low-risk vulnerabilities, further enhancing system security. The security assessment results indicate that a total of 8 vulnerabilities were discovered during the security tests, of which 3 were classified as medium-risk and 5 as low-risk. In terms of the remediation status, all medium-risk vulnerabilities have been fixed, while the low-risk vulnerabilities are in the process of being resolved. From the impact assessment perspective, medium-risk vulnerabilities were considered to have a significant impact, whereas low-risk vulnerabilities were assessed as having a minor impact. These results suggest that although there are some security concerns in the system, the platform has taken proactive measures to address these issues, particularly by prioritizing the resolution of higher-risk vulnerabilities, demonstrating a commitment to user data security and responsible management. Moreover, the ongoing security improvement efforts reflect the platform's continuous dedication to ensuring system security.

6. Conclusion

The smart tourism platform provides strong technical support for innovation in rural tourism services, significantly enhancing visitor experiences and scenic area management efficiency. Through a multi-layer architecture design and the integration of advanced technologies, the platform has achieved functions such as intelligent guiding, personalized recommendations, and visitor flow management, addressing many pain points in the informationization of rural tourism. System performance evaluations show that the platform excels in response speed, reliability, and user satisfaction, bringing significant economic and environmental benefits. However, there is still room for improvement in accuracy and security. In the future, efforts should continue to optimize algorithms, strengthen data security, and explore new technology applications to further promote the intelligent and sustainable development of rural tourism.

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